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ABSTRACT

This paper describes a project implemented in two classrooms at the University of Wyoming's College of Education laboratory school. Forty-four students in the second and third grade participated. The "In Search of Bicycles" project asked students to consider how technology is used and how it affects the environment. Students then began to identify the distinguishing features of mountain bikes and road bikes by using students' bikes for analysis. Classifying of the bicycles was done outside the classroom, followed by students creating bar charts to describe and summarize their data. New categories had to be added and identifying characteristics noted once again (e.g., "BMX racers," "banana bikes," and "dirt bikes"). Further investigation led to refinement of the data-collecting procedures and explanations as to the relative distribution of the various types of bikes. Data analysis was conducted relative to student age, social status, and income levels and in relation to the physical aspects of the local terrain and climate. Further extensions of the activity are suggested. (EH)

WHERE NO BICYCLE HAS GONE BEFORE:

A DATA COLLECTION AND ANALYSIS PROJECT FOR THE EARLY ELEMENTARY GRADES

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ABSTRACT

Second and third graders identified the distinguishing features of "mountain bikes" and "road bikes" to learn how people have designed, and continually modified, a familiar item of technology for the purpose of adapting to different kinds of environments. Working in pairs, students conducted an investigation outside the classroom by classifying on a checklist the first ten bikes they encountered on school grounds as either a mountain bike or a road bike. Partners had to cooperate with each other during the collection of these data by solving problems of classification (some bikes did not fit neatly into one category or the other) and by achieving a consensus as to the reasons why they decided to subsume each bicycle under one category and not the other. Upon returning to the classroom, groups-of-two created bar charts for describing and summarizing their bicycle data. According to students, several new categories for classifying different kinds of bikes were needed, such as "boy's and girl's bikes," "BMX racers," "banana bikes," and "dirt bikes". The distinguishing features of each model were once again identified; students revised their original checklists and bar charts in preparation for a second round of investigation in order to refine their data-collection procedures and subsequent explanations for the relative distribution of the various types of bicycles. To formulate hypotheses for explaining this distribution of bicycle types, partners analyzed their data in light of knowledge about the age, social status, and income levels of students at their school and in relation to the physical aspects of the environment, such as the local terrain and climate. (Author)

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Introduction and Overview

Teachers can motivate young learners to construct meaningful interpretations of complex concepts and relationships by providing students with opportunities to collect and analyze data relevant to their interests outside of school. During the project described in this paper, second and third graders identified, compared, and then classified the distinguishing attributes of "mountain bikes" and "road bikes" to learn how people have used technology for the purpose of adapting to two different kinds of environments. Bicycles served as the integrating theme in this investigation because they are a familiar and interesting item of technology to most children. "Technology and human adaptation" served as the primary focus of the project in the effort to teach students how technology, viewed as a significant aspect of all human cultures, has enabled people to live successfully within a wide variety of social and natural settings; in contrast, animals without technology and culture generally must depend on a relatively gradual, "hit or miss" process of change in both physical form and instinctive behaviors to be successful in different environments. An important developmental goal of this project, then, was to encourage second and third graders to begin constructing a knowledge base upon which to build a more sophisticated conceptual framework in the later grades for distinguishing between the social-cultural mechanisms by which people adapt to their environments and the process of natural selection by which animals without culture and technology adapt to their environments.

Although road bikes and mountain bikes are similar in many respects, each is technologically distinct in the sense that people originally designed, and have continually modified, them in special ways for the purpose of adapting to different sets of environmental conditions. "Technology" was broadly conceived and defined as any kind of machine that helps people go somewhere or do something. For example, people invented bicycles to travel and transport materials from place to place because, in many instances, this mode of technology was more efficient than walking and carrying materials. "Environment" was defined in a manner that included both students' physical surroundings -- local terrain, seasonal temperatures, type and amount of yearly precipitation -- and students' social surroundings -- family members, teachers, and friends. Thus, prior to collecting and analyzing the bicycle data, the concepts of "technology" and "environment" were explicitly discussed with students in terms of tangible objects and familiar people; however, no such preformed definition of the "adaptation" concept was presented to students. We believed that the concept of adaptation should be taught and understood as a relationship between any plant or animal species and its environment. Adaptation, therefore, represents a "dynamic process" -- rather than a person, place, or thing -- to the extent these relationships change, or evolve, over time as organisms develop new and different ways of adjusting to changes in the environment and its resources. Therefore, the instructional strategy most central to this project involved providing students with opportunities to

construct meaningful interpretations of concepts and relationships by reflecting on firsthand exploratory experiences. The main instructional objective was for learners to understand the process by which human beings adapt to different kinds of environments through the application of technologies.

This project was implemented in two classrooms at the University of Wyoming's College of Education laboratory school. Second and third graders were combined in each classroom; a total of 44 students participated. What follows is a description of the lesson procedures and materials used for the "In Search of Bicycles" project along with some of the students' reactions to participating in the project. In the concluding section, additional ideas and activities are suggested for extending children's learning in relation to the study of bicycles as a familiar item of adaptive technology.

Lesson Procedures

1. Students brainstorm various examples of technology that can be observed in the classroom and around the school for the purpose of: (a) activating existing knowledge about technology that will facilitate the construction of meaning during subsequent learning activities (b) sharing and discussing how one another thinks about technology to establish a working definition of the concept, and (c) helping the teacher assess where children are at in their thinking about technology before instruction begins; that is, to find out what ideas, images, causal relationships, generalizations, and misconceptions students currently have about the role of technology in human adaptation.

Some possible examples of technology that children might suggest include pencil sharpeners, computers, clocks, bicycles, cars, and trucks. Discuss how these technologies help people: Computers help people create, store, and communicate information; clocks help people organize their daily schedules so they can "stay on time"; trucks help people move or transport large amounts of heavy materials, like sand, gravel, and cement. Young learners are likely to conceptualize technology as machines, as opposed to the techniques of their use or as the knowledge that exists in people's heads concerning technology.

Help students understand the meaning of "environment" by brainstorming and discussing prominent features of the surrounding terrain (hilly or flat), aspects of an urban versus a rural setting (lots of buildings or open country), temperature and precipitation (cold or hot most of the year, snowy or rainy, windy or calm). Remind students that if we think of the environment as all the objects, plants, and animals around us and with which we can interact, then we should also consider other people to be an important part of our environment.

2. Ask for volunteers who are willing to bring their mountain bike or road bike into the classroom to provide students with two concrete examples of technology to observe and analyze. Help students compare and contrast the features of each kind of bicycle. Draw a T-Chart on the board or on a large piece of butcher paper to record and classify similarities and differences (see Figure 1).

Figure 1. T-Chart for recording similarities and differences between road bikes and mountain bikes.

ROAD BIKES	MOUNTAIN BIKES
Example: Road bikes usually have thin, smooth tires.	Example: Mountain bikes usually have wide, knobby tires.

Teachers may want to initiate this "compare and contrast activity" by modeling an example: "I see that both kinds of bikes have two tires each, but the tires look different (comparing). In what ways are the tires on the road bike different from the tires on the mountain bike (contrasting)?" Continue probing in this manner by asking students: "What other similarities and differences can you see in the two kinds of bikes?" For example, "they both have handlebars, but the mountain bike's handlebars are straight and padded ("spongy") whereas the road bike's handlebars are curved and have tape on them".

3. After the relevant features of mountain bikes and road bikes have been recorded on the <u>T-Chart</u>, ask students to write a short letter to one of their friends in the class explaining why the bicycles have different features. Allow students to refer to the <u>T-Chart</u> as they write and remind them to think about the different environments for which each kind of bike was designed.

Teachers may want to facilitate the writing process by asking: "Now that you have identified many of the ways road bikes and mountain bikes are different from each other, can you explain these differences in a letter written to a friend who thinks both kinds of bikes are the same? Why do you think mountain bikes have wide, knobby tires and road bikes have thin, smooth tires? When and where are these two bikes usually ridden? For what purpose? How do the special features of each bike help riders on the road or in the mountains?"

4. During the next stage of the lesson, students go outside and, working in pairs, use the Checklist for Bicycles (see Figure 2) to survey at least 10 bikes parked around the school building. Partners should cooperate with each other when making the decision to classify each bike as either a "road bike" or a "mountain bike" on their checklists. Teachers may wish to teach students some social skills before and during this activity. Emphasize that students should remain in their groups-of-two and, using the features of each kind of bicycle previously recorded on the T-Chart, help each other decide how to classify each bike and to describe in as much detail as possible along the right-hand side of the "checklist" why each bike was classified in a particular way.

Unless the bicycles to be classified have been prearranged by the teacher, many of the bikes students encounter will not fit neatly into one category or the other and, as a result, "disagreements" (not "arguments") may occur. Specifically, then, students must be prepared to engage in a process of "constructive controversy": "For controversies to be managed constructively, people need collaborative and conflict-management skills" (Johnson & Johnson, 1991, p. 281). Partners must be able to discuss problematic situations -- cases where it is not clear how to classify a particular bike -- in a rational manner by focusing on each other's ideas and not each other's personalities. The goal here is for partners to reach a consensus concerning how to classify the bike in question and to list, for example, three

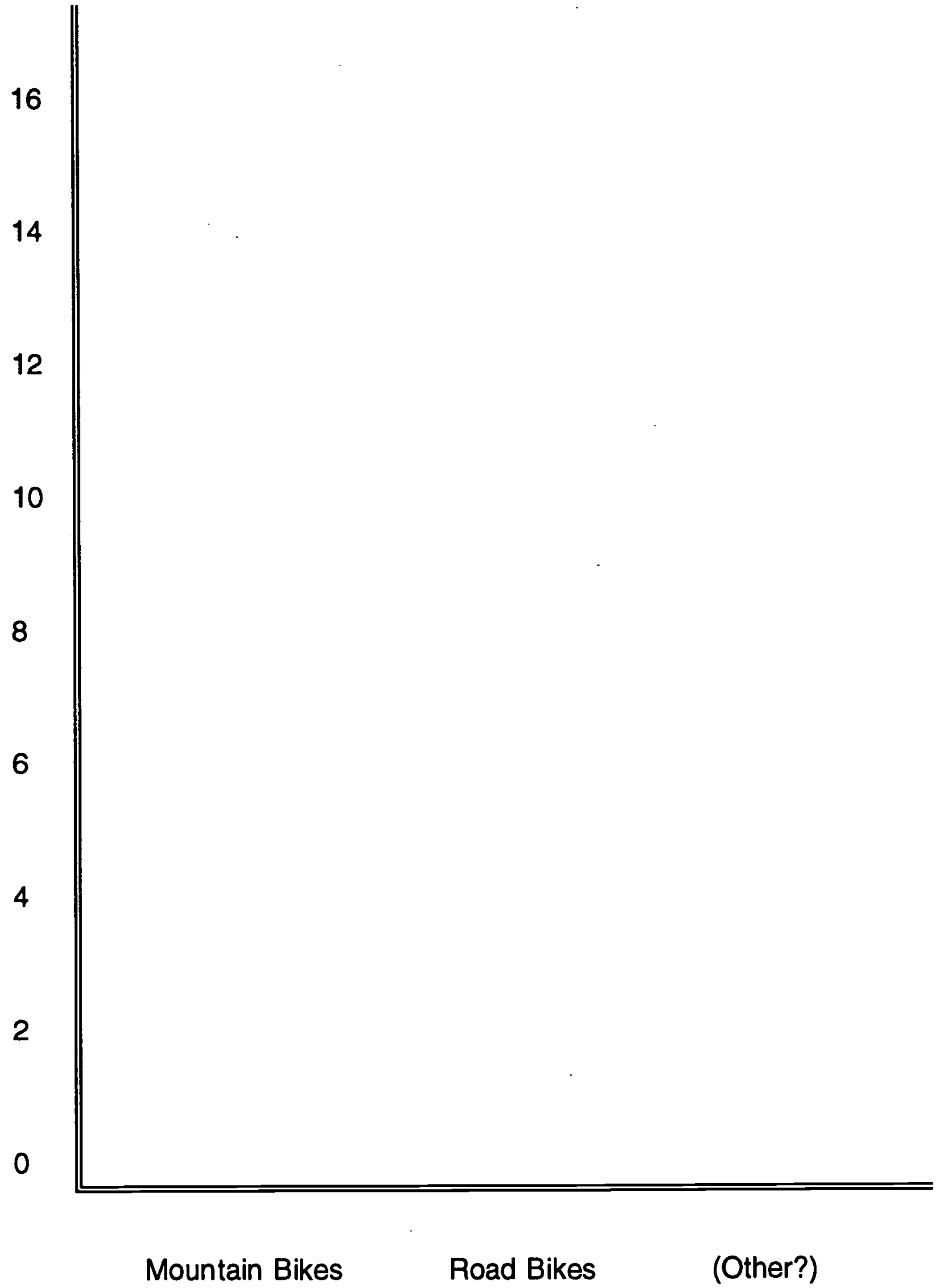
reasons why they decided as a group to classify the bike as a "road" or "mountain" model.

Figure 2. Checklist for classifying bicycles.

	ROAD BIKE OR MOUNTAIN BIKE?	WHY DID YOU DECIDE THAT IT WAS THIS KIND OF BIKE?
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

5. Once students have returned to the classroom, partners can use the Bar Chart (see Figure 3) to summarize and display their data. Now is the time to help students construct meaningful interpretations of how people use technology to adapt to different environments. Teachers may ask students: "Did you find more mountain bikes or more road bikes? Why do you think this was so?" The idea here is to relate the kinds of bicycles to the local environment and people. Students in one class claimed that there were more mountain bikes than road bikes parked around their school because (there was some snow and ice on the ground at the time) the knobby tires of mountain bikes helped riders get better traction, like snow tires on a car. Some children expressed the belief that because we all lived near the mountains in Laramie, Wyoming, most students at their school would want to have mountain bikes. While it was acknowledged by most students that our surrounding physical environment was the reason why more mountain bikes than road bikes were found, several groups maintained that this discrepancy could also have been due to the "fact" that mountain bikes "looked cooler" than road bikes and were more fun to ride, "because you can go anywhere with a mountain bike but not with a road bike". Finally, a surprising number of children reasoned that "poor kids" probably could not afford mountain bikes because they are expensive. These responses made it clear to the class that factors related to both students' physical and social environments influenced the type of bicycle an individual owned.

Figure 3. Bar chart for partners to summarize and display bicycle data.



Students were also asked: "Did your group ever have any difficulty classifying a bike? How did you end up deciding whether it was a mountain bike or a road bike? Did you make up any rules for how to classify the bikes you saw?" Several students maintained that two categories were not enough to classify all the different kinds of bikes they found. For example, there were "girls bikes and boys bikes", "little bikes and big bikes", "banana bikes" (in reference to the shape of the seat and characteristic "ape-hanger" handlebars), "low-rider bikes", "BMX bikes" (with a number attached to the bike to identify it in a BMX race), and, finally, there were "dirt bikes". When asked how we might change the way we collected our data, it was suggested that a third category be added to the Checklist for Bicycles "to put all the bikes we're not sure about in". Some students said this third category could be called the "in between", "half and half", or simply the "other" category; alternatively, some students insisted that creating separate categories for each kind of bike would be better.

To extend the learning process at this point, students could be invited to "recycle" through the lesson. To do this, partners design their own T-Charts by adding extra columns to accommodate different kinds or "classes" of bikes. Next, students list in each column of their revised T-Charts the distinguishing characteristics of, for example, "banana bikes," "BMX bikes," and "boys and girls bikes". Teachers may wish to stipulate that students generate at least two more categories in addition to the original "road bike/mountain bike" dyad

before they will be allowed to revise their Checklist for Bicycles and go outside once again to repeat the data collection process. Adding a single "other" or "in between" category will not facilitate an active process of problem solving and decision making among partners during the second round of data collection because it becomes too easy for students to "give up" on attempting to determine what specific features define a particular kind of bicycle through a sustained analysis by simply tossing every problematic case into the "other" category. Finally, students could now revise their original letters to a friend (see step # 3) by incorporating the new information and knowledge they have about different kinds of bicycles.

Some reasons for having students repeat the data collection process are: (a) to give students a chance to design their own, unique T-Charts, Checklists, and Bar Charts, (b) motivating students to get involved in an active process of data manipulation and analysis; this will occur as partners strive to construct increasingly more detailed and sophisticated schemata for understanding the many ways in which bicycles differ according to their primary adaptive function, for example, as a "racing bike" or as a "touring bike," (c) encouraging students to invest a greater degree of ownership in the learning process, (d) to provide further opportunities for partners to practice and refine their social skills by cooperating with each other in the production of new knowledge.

6. At the end of the third day the project was brought to closure when the teacher suggested that students were now capable of creating their own T-Charts, Checklists, and Bar Charts to use in comparing and contrasting different items of human technology or even different kinds of animals. Students were invited to share any and all findings they believed would be of interest to the rest of the class and to ask the teacher for a time when they could make their presentations. Students said they could compare, for example, four-wheel-drive trucks and passenger cars to find out how these two pieces of technology help people adapt to their environments, or how ants and bees both adapt to their environments in similar but also in different ways because "bees can fly but ants can't".

Conclusion

Teachers and students may wish to extend their understanding of bicycles as an important item of technology in people's lives by learning more about some of the following concepts, answering the questions, and/or by participating in one or more of the activities:

1. Concept development of: adaptation, technology, environment, interaction, system, erosion, degradation, innovation.

2. The mountain bike was developed by people in response to the requirements of sports and leisure, not for the instrumental purpose of transportation proper. What other cultures have designed and used different kinds of bicycles and what was their purpose and environment?

3. Compare and contrast mountain bikes and road bikes in terms of their impact on the environment for which they were designed.

4. Where and when were the first mountain bikes invented? How has the technology of mountain bikes changed (or "evolved") over the last 20 years? In what ways does the mountain bike represent "technological innovation" and "adaptation" over time relative to specific environmental conditions?

5. Plan a week-long mountain bike expedition with a group of friends. Where would you go (make a map), what supplies would be needed (make a list), and how would you carry all that you needed (draw a picture)?

6. Create a "Mountain Bike Bulletin Board" in your classroom that illustrates an imaginary endurance course for riders to follow. Include obstacles, observation points for spectators, a concession stand, and a repair shack. Diagram a mountain bike showing the names, locations, and functions of each part.

7. Design your very own "Dream Bike," equipping it with all the latest whistles and bells you can think of and present your "creation" to the class. In what kind of environment did you design your bike to be ridden?

8. Invite the owners of a local bicycle shop to visit your school and discuss what it is like to run a bicycle business? Better yet, visit the bicycle shop for a guided tour and demonstrations.

9. Compose an "Ecology Awareness Pamphlet for Mountain Bikers" in which you list the do's and don'ts for bikers who plan to travel in wilderness areas.

How can bikers help preserve the environment (don't litter, don't be loud) and protect themselves from crime, animals and bad weather?

10. Create some games that people could play while riding mountain bikes. What rules and regulations would have to be followed?

11. What if, suddenly, your town ran out of gasoline to power cars, buses, trains, and motorcycles, and the only mode of transportation left was, you guessed it, bicycles. What changes do you think you would see at home and in the community as a result of everyone having to ride bikes now?

12. What does mountain bike technology owe to the NASA space program?

13. Write a "What Every Mountain Bike (or Road Bike) Owner Should Know" manual with sections on what to look for when purchasing a new bike, how to take care of and maintain your bike properly, rules of bike safety, and how to be a courteous and responsible rider. You could also include a question and answer section on repairing bicycles; for example, how do you find an air leak in a tire and repair it?

14. Bring your own bike to school and give a demonstration speech to the class in which you explain how you became interested in bike riding, where you ride, what clubs you belong to, activities you enjoy doing on your bike, and tips for skillful riding.

References

Johnson, D.W., & Johnson, F.P. (1991). Joining together: Group theory and group skills. Englewood Cliffs: Prentice-Hall.

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